SPheno, a brief update on recent developments

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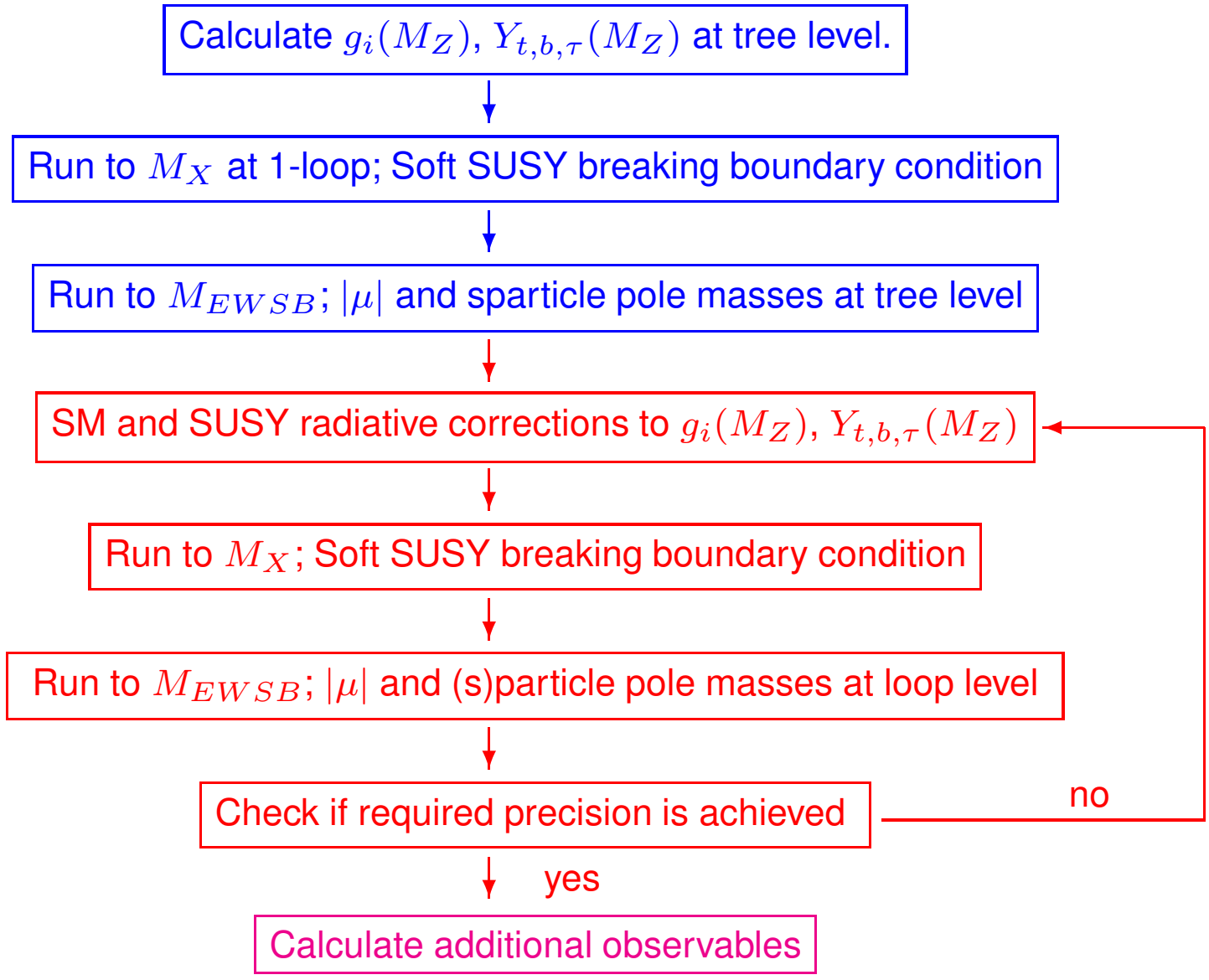
spectra, RGE codes schematic, 'traditional approach'

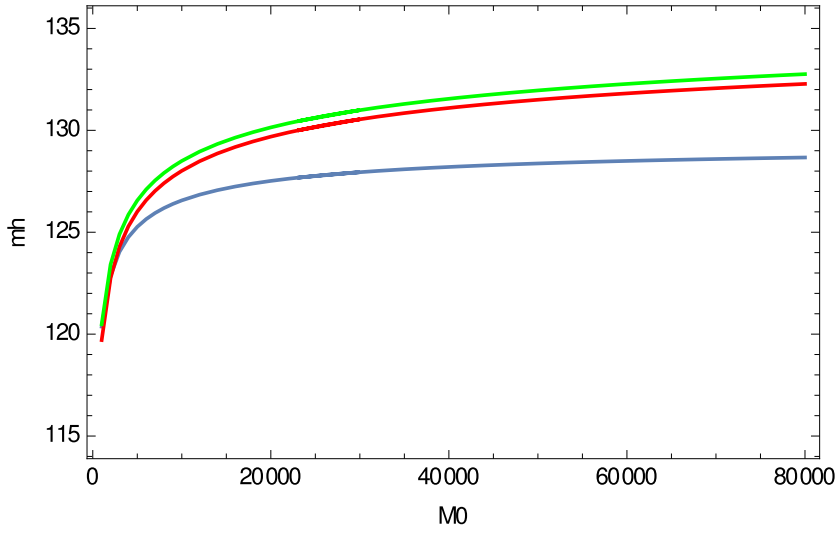


New: decoupling of all SUSY particles at M_{SUSY}

- calculate $g_i^{\rm SM}$ and $Y_i^{\rm SM}$ at m_Z
- $\lambda^{\rm SM}$: 1st iteration value for $m_H = 125$ GeV used,
  later iterations: calculated from $\lambda^{\rm SM}(M_{SUSY})$ via RGE running to m_Z
- 2-loop SM-RGE up to M_{SUSY} (usually $\sqrt{m_{\tilde{t}_1} m_{\tilde{t}_2}}$ with tree-level stop masses)
- $g_i^{\rm SM}, Y_i^{\rm SM} \to g_i^{\rm SUSY}, Y_i^{\rm SUSY}$
  resummation of large $\tan\beta$ effects using A.Crivellin et al. arXiv:1103.4272
- from here same procedure to get soft parameters at M_{SUSY} but start SUSY RGE running, if necessary, from M_{SUSY}
- match at M_{SUSY} $m_h^{\rm MSSM} = m_H^{\rm SM}$ to get $\lambda^{\rm SM}$ (see also talk by Alexander Voigt)
  in SPheno: at the two-loop level
  - 1-loop: complete diagramatic calc. including p^2-dep.
  - 2-loop SUSY calc.: routines from Pietro
    $O(\alpha_t\alpha_s + \alpha_b\alpha_s + (\alpha_t+\alpha_b)^2 + \alpha_b\alpha_\tau + \alpha_\tau^2)$
  - 2-loop SM calc.: S.P. Martin, D.G. Robertson, arXiv:1407.4336, $O(\alpha_t\alpha_s)$ with $p^2 = 0$
- 2-loop SM-RGE down to m_t to re-calculate m_H at the 2-loop level.

Comparision with SUSYHD 1.0.2, mSUGRA scenarios

$A_0 = -2M_0$



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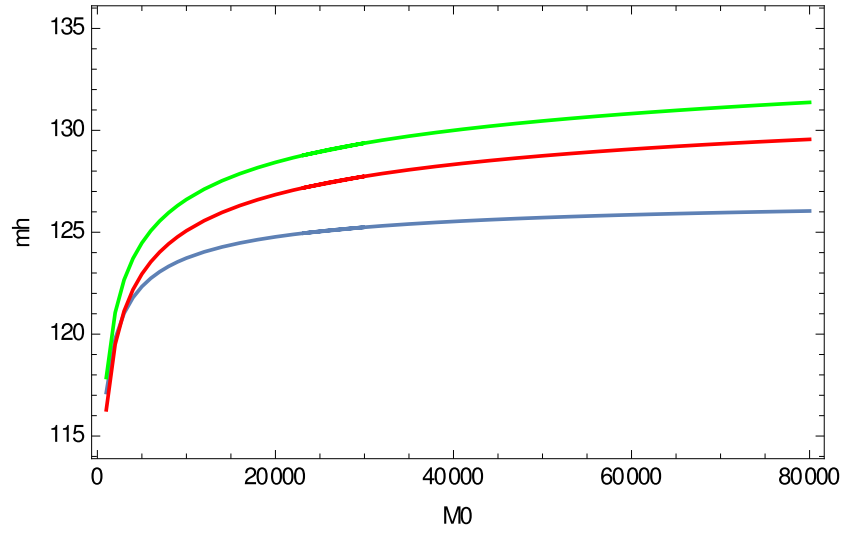

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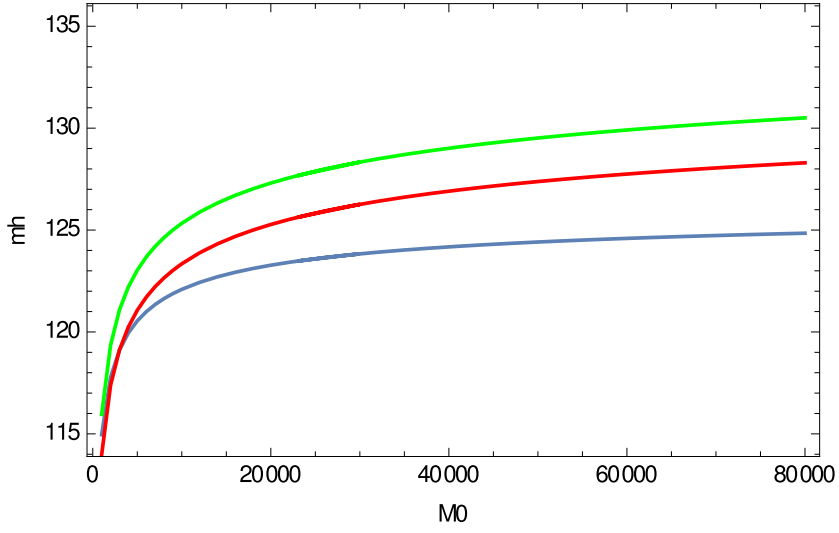

$M_{1/2} = M_0$, $\tan\beta(M_{SUSY}) = 10$, $\mu > 0$

m_h: SPheno standard, but using SM RGEs up to $M_{SUSY} = \sqrt{m_{\tilde{t}_1} m_{\tilde{t}_2}}$

m_h: matching $m_h^{\rm MSSM} = m_H^{\rm SM}$ at M_{SUSY}, running $\lambda^{\rm SM}$ to m_t

m_h: SUSYHD handing over all parameters at M_{SUSY}

preliminary results

Comparision with SUSYHD 1.0.2, mSUGRA scenarios

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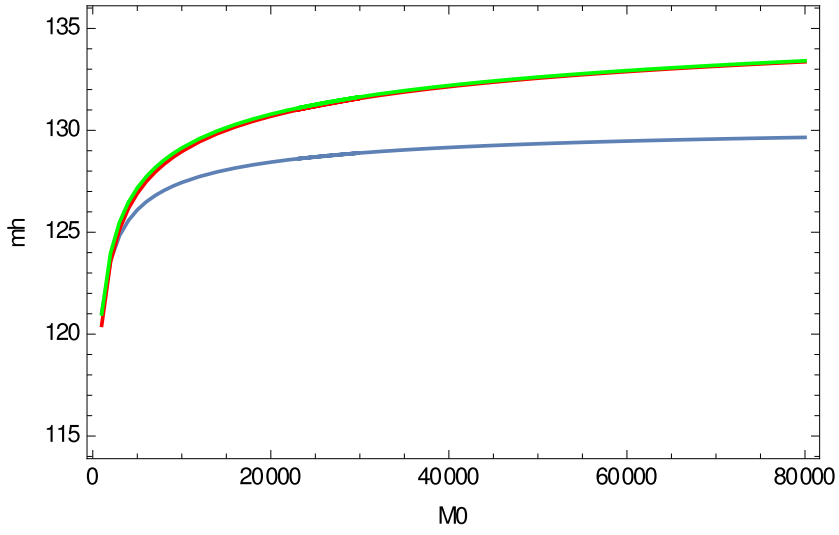

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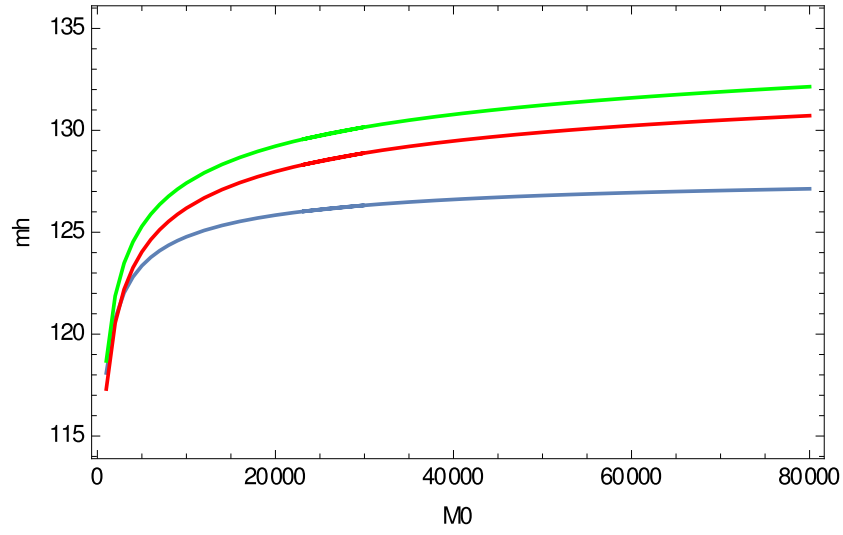

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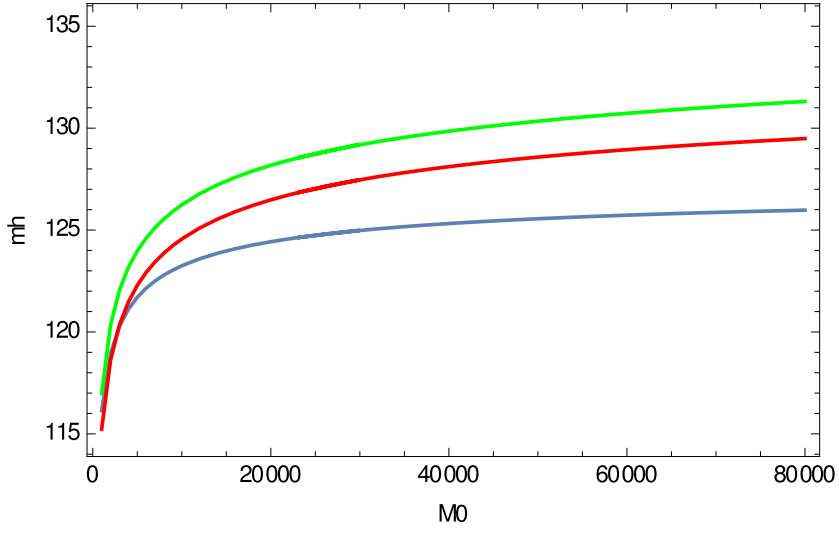

$M_{1/2} = M_0$, $\tan\beta(M_{SUSY}) = 40$, $\mu > 0$

m_h: SPheno standard, but using SM RGEs up to $M_{SUSY} = \sqrt{m_{\tilde{t}_1} m_{\tilde{t}_2}}$

m_h: matching $m_h^{\rm MSSM} = m_H^{\rm SM}$ at M_{SUSY}, running $\lambda^{\rm SM}$ to m_t

m_h: SUSYHD handing over all parameters at M_{SUSY}

preliminary results

Future

- include $O(\alpha_t^2)$ contribution to $m_H^{\rm SM}$
- get an understanding of the differences between SPheno and SUSYHD results
- finish implementation of 'traditional' EFT approach at 2-loop level
- include split-SUSY
- include some high scale motivated large hierarchies, e.g.
  $m_{\tilde{q}} \simeq m_{\tilde{g}} \gg m_{\tilde{t}_i}, m_{\tilde{b}_i} \gg M_1, M_2, \mu$
- however general multiple scale is not possible: even taking an effective model with 14 mass parameters (e.g. taking sfermion masses for first two generations equal but different for $\tilde{q}_L$, $\tilde{u}_r R$, $\tilde{d}_R$, $\tilde{l}_L$, $\tilde{l}_L$) gives $14! \simeq 9 \cdot 10^{10}$ mass orderings! (expect about 10^5 GB code)